

1 WHAT IS CLAIMED IS:

- 1 1. An optical communications system for communicating information comprising:  
2 a receiver subsystem comprising:  
3 an optical splitter for splitting a composite optical signal having at least two  
4 subbands of information and at least one tone into at least two optical  
5 signals, each optical signal including a different one of the subbands and  
6 one of the tones; and  
7 at least two heterodyne receivers, each heterodyne receiver coupled to receive one  
8 of the optical signals from the optical splitter for recovering information  
9 from the subband contained in the optical signal, each heterodyne receiver  
10 comprising:  
11 a heterodyne detector for mixing an optical local oscillator signal with the  
12 optical signal to produce an electrical signal which includes a  
13 frequency down-shifted version of the subband and the tone of the  
14 optical signal; and  
15 a signal extractor coupled to the heterodyne detector for mixing the  
16 frequency down-shifted subband with the frequency down-shifted  
17 tone to produce a frequency component containing the information.
- 1 2. The optical communications system of claim 1 wherein the optical splitter includes a  
2 separate splitter for separating each subband from the composite signal.
- 1 3. The optical communications system of claim 1 wherein the optical splitter includes an  
2 optical power splitter for splitting the composite optical signal into optical signals which are  
3 substantially the same in spectral shape.

1 4. The optical communications system of claim 1 wherein the optical splitter includes a  
2 wavelength division demultiplexer for wavelength division demultiplexing the composite optical  
3 signal into the optical signals.

1 5. The optical communications system of claim 1 wherein the optical splitter includes a  
2 wavelength-selective optical power splitter for splitting the composite optical signal into optical  
3 signals, each optical signal including a different primary subband and attenuated other subbands.

1 6. The optical communications system of claim 1 wherein:  
2 the electrical signal further comprises direct detection components; and  
3 the frequency down-shifted version of the subband does not spectrally overlap with the  
4 direct detection components.

1 7. The optical communications system of claim 1 wherein the heterodyne detector  
2 comprises:  
3 an optical combiner for combining the optical local oscillator signal and the optical  
4 signal; and  
5 a square law detector disposed to receive the combined optical local oscillator signal and  
6 optical signal.

1 8. The optical communications system of claim 1 further comprising:  
2 an optical wavelength filter coupled between the optical splitter and one of the  
3 heterodyne receivers.

1 9. The optical communications system of claim 1 wherein the tone for each optical signal is  
2 located at an optical carrier frequency for the corresponding subband.

1 10. The optical communications system of claim 1 wherein the tone for each optical signal  
2 includes a pilot tone located at a frequency other than at an optical carrier frequency for the  
3 corresponding subband.

1 11. The optical communications system of claim 1 wherein at least two optical signals have  
2 tones at the same frequency.

3 12. The optical communications system of claim 1 wherein the frequency component  
4 includes a difference component.

1 13. The optical communications system of claim 1 wherein the receiver subsystem further  
2 comprises:

3 at least two FDM demultiplexers, each FDM demultiplexer coupled to receive the  
4 frequency component from one of the heterodyne receivers for FDM  
5 demultiplexing the frequency component into a plurality of electrical low-speed  
6 channels.

1 14. The optical communications system of claim 13 wherein the receiver subsystem further  
2 comprises:

3 at least two QAM demodulation stages, each QAM demodulation stage coupled to one of  
4 the FDM demultiplexers for QAM demodulating the electrical low-speed  
5 channels.

1 15. The optical communications system of claim 1 further comprising:  
2 a transmitter subsystem for generating the composite optical signal.

1 16. The optical communications system of claim 15 wherein the transmitter subsystem  
2 comprises:

3 at least two transmitters, each for generating one of the subbands, each transmitter using a  
4 different optical carrier frequency; and  
5 an optical combiner coupled to the transmitters for optically combining the subbands into  
6 the composite optical signal.

1 17. The optical communications system of claim 15 wherein the transmitter subsystem  
2 comprises:  
3 at least two electrical transmitters for generating electrical channels;  
4 an FDM multiplexer coupled to the electrical transmitters for FDM multiplexing the  
5 electrical channels into an electrical high-speed channel, the electrical high-speed  
6 channel further including the tones; and  
7 an E/O converter coupled to the FDM multiplexer for converting the electrical high-speed  
8 channel into the composite optical signal.

1 18. A method for recovering information from a composite optical signal containing the  
2 information, the method comprising:  
3 receiving a composite optical signal having at least two subbands of information and at  
4 least one tone;  
5 splitting the composite optical signal into at least two optical signals, each optical signal  
6 including a different one of the subbands and one of the tones; and  
7 for each optical signal:  
8 receiving an optical local oscillator;  
9 detecting the optical signal using heterodyne detection and the optical local  
10 oscillator to produce an electrical signal which includes a frequency down-  
11 shifted version of the subband and the tone of the optical signal; and  
12 mixing the frequency down-shifted subband with the frequency down-shifted tone  
13 to produce a frequency component containing the information.

1 19. The method of claim 18 wherein the step of splitting the composite optical signal into at  
2 least two optical signals includes separating each optical signal from the composite optical  
3 signal.

1 20. The method of claim 18 wherein the step of splitting the composite optical signal into at  
2 least two optical signals includes splitting the composite optical signal into optical signals which  
3 are substantially the same in spectral shape.

1 21. The method of claim 18 wherein the step of splitting the composite optical signal into at  
2 least two optical signals includes wavelength division demultiplexing the composite optical  
3 signal into the optical signals.

1 22. The method of claim 18 wherein the step of splitting the composite optical signal into at  
2 least two optical signals includes wavelength selectively splitting the composite optical signal  
3 into optical signals, each optical signal including a different primary subband and attenuated  
4 other subbands.

1 23. The method of claim 18 wherein the step of detecting the optical signal using heterodyne  
2 detection and the optical local oscillator comprises:  
3 optically combining the optical local oscillator signal and the optical signal; and  
4 detecting the combined optical local oscillator signal and optical signal using square law  
5 detection.

1 24. The method of claim 18 wherein the tone for each optical signal is located at an optical  
2 carrier frequency for the corresponding subband.

1 25. The method of claim 18 wherein the tone for each optical signal includes a pilot tone  
2 located at a frequency other than an optical carrier frequency for the corresponding subband.

1 26. The method of claim 18 further comprising, for each optical signal:  
2 FDM demultiplexing the frequency component into a plurality of electrical low-speed  
3 channels.

1 27. The method of claim 26 further comprising, for each optical signal:  
2 QAM demodulating the electrical low-speed channels.

1 28. The method of claim 18 further comprising:  
2 encoding the information in a composite optical signal; and  
3 transmitting the composite optical signal across an optical fiber.

1 29. The method of claim 28 wherein the step of encoding the information in a composite  
2 optical signal comprises:  
3 encoding the information onto subbands, each subband located at a different optical  
4 carrier frequency; and  
5 optically combining the subbands to produce the composite optical signal.

1 30. The method of claim 28 wherein the step of encoding the information in a composite  
2 optical signal comprises:  
3 generating electrical channels;  
4 FDM multiplexing the electrical channels into an electrical high-speed channel, the  
5 electrical high-speed channel further including the tones; and  
6 converting the electrical high-speed channel from electrical to optical form to produce the  
7 composite optical signal.

1 31. The method of claim 28 wherein the step of encoding the information in a composite  
2 optical signal comprises:  
3 receiving an optical carrier; and  
4 modulating the optical carrier with the information using a raised cosine modulation  
5 biased at a point substantially around a  $V_{\pi}$  point.